



Concepts of Industrial Hygiene

Exposure / PPE / Warnings

Applied to COVID-19 & Masks

NY State Data

Stephen E. Petty, P.E., C.I.H., C.S.P. - EES Group, Inc.

September 30, 2021

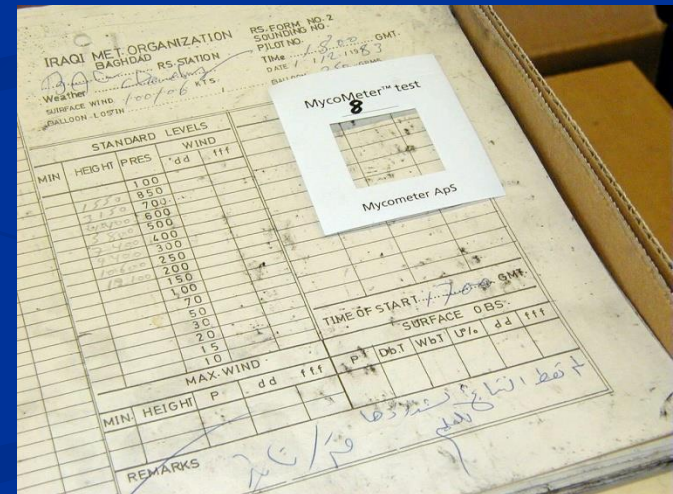
BACKGROUND



- **President and Owner of EES Group, Inc. (Forensic Engineering Company – Since 1996 – 25 years).**
- **Section Manager and Sr. Research Engineer, Columbia Gas (10 years).**
- **Sr. Research Engineer, Battelle (10 years).**

PETTY QUALIFICATIONS

- Education: B.S. Ch. E., M.S. Ch. E. (honors at both levels) and M.B.A. (1st in Class).
- Sr. Research Scientist – Battelle.
- Sr. Research Engineer/Section Manager - R&D – Columbia Gas.
- President, EES Group – Engineering EHS Company, Columbus, OH. – 100s of projects.
- CIH (National Certification), C.S.P. & Professional Engineer (OH, FL, PA, WV, KY, and TX).
- National Exposure/PPE Expert (e.g., Monsanto Roundup, DuPont C-8); ~400 Cases.
- Selected to determine general causation outside of litigation on dozens of projects (e.g., Iraqi Docs – Allegany Ballistics Lab – Columbus Blue Jackets; Prof. Hockey locker room – Columbus College of Art & Design, CMH Airport RA).
- Adjunct Professor – Franklin University (Teach Environmental and Earth Sciences).
- Nine U.S. Patents – mostly wrt Heat Pumps.



PETTY QUALIFICATIONS

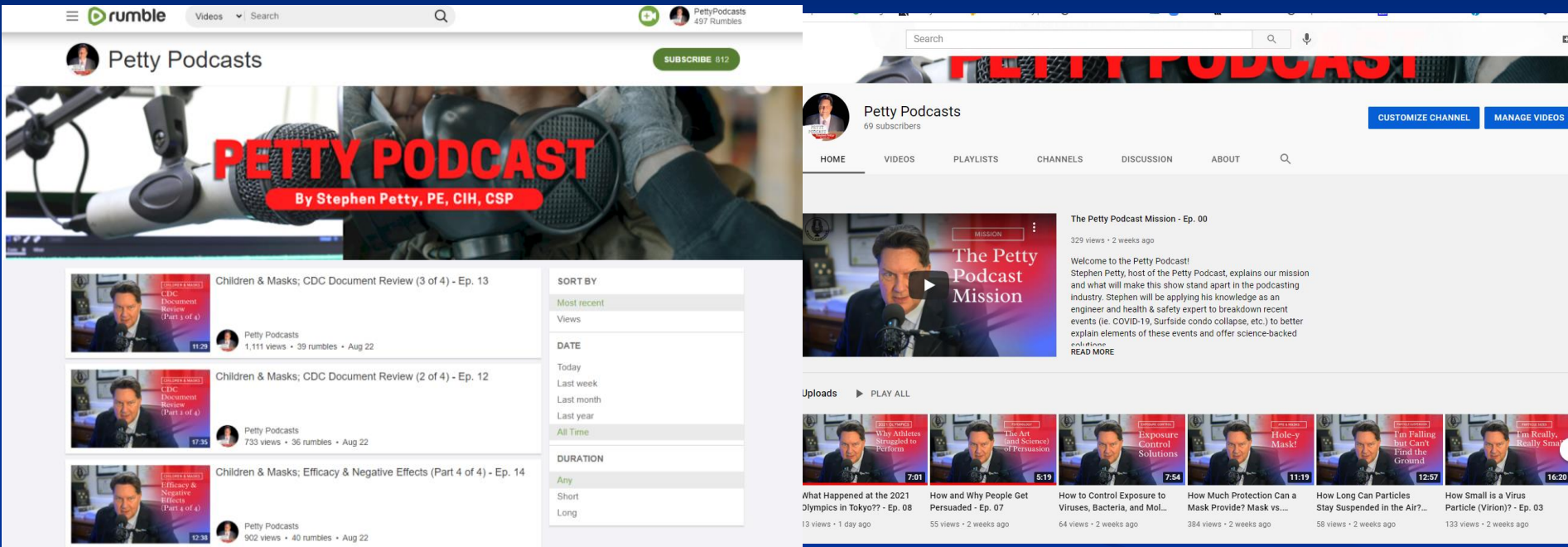
➤ Memberships:

- American Industrial Hygiene Association (AIHA).
- American Board of Industrial Hygiene (ABIH).
- American Conference of Governmental Ind. Hygienists (ACGIH).
- American Institute of Chemical Engineers (AIChE).
- American Society of Refrigeration, Air Conditioning and Refrigeration Engineers (ASHRAE); Member ASHRAE 40 Std. and TC 8.3.
- American IAQ Council.
- Sigma Xi.



PETTY PODCASTS

All this information detailed in Video Petty Podcasts #2 through #6:




In Google you should find us at Rumble & YouTube – the links are:

<https://rumble.com/c/PettyPodcasts> – not censored – see #5-6 and #11-14

https://www.youtube.com/channel/UCwPHggMiWwjpd5dA-Og_Ag – censored!

SCHOOL DISTRICT SUPPORT

**Oakstone Academy (Special Needs School) – Westerville, OH
– Dr. Becky Morrison – Two Podcasts – No Masks /
Engineering Controls – Implemented August 2020:**




45:11 PREVIEW

Dr Becky and Stephen Petty Pt 1

YouTube · Dr Douglas G Frank

Mar 22, 2021

3 key moments in this video



55:07 PREVIEW

Dr Becky and Stephen Petty Pt 2

YouTube · Dr Douglas G Frank

Mar 22, 2021

Part 1 Video Link (Dr. Morrison): <https://rumble.com/vkhln-dr-becky-oakstone-academy-and...>

Part 2 Video Link (Stephen Petty): <https://youtu.be/oYEo4T6V25w>

School and Students Doing Well without Masks for 2020-2021 School Year

LITIGATION SUPPORT

1. Boone County, Kentucky – Testified on May 17, 2021 against the Governor's Mask Mandate.



Filing # 125367129 E-Filed 04/21/2021 04:23:35 PM

IN THE CIRCUIT COURT OF THE EIGHTH JUDICIAL CIRCUIT
IN AND FOR ALACHUA COUNTY, FLORIDA

JUSTIN GREEN,

Case No. 2020-CA-1249

Plaintiff,

v.

ALACHUA COUNTY,

Defendant.

PLAINTIFF'S EXPERT WITNESS DISCLOSURE

COMES NOW JUSTIN GREEN ("Plaintiff"), notifying all interested parties of the retention of Plaintiff's Expert Witness, Stephen E. Petty, P.E., C.I.H., C.S.P., and saying:

Attached hereto are the following exhibits:

Exhibit A – *Curriculum Vitae* of Stephen E. Petty, P.E., C.I.H., C.S.P.

Exhibit B – List of Prior Cases Wherein Expert Testified

Exhibit C – Expert Witness Report of Stephen E. Petty, P.E., C.I.H., C.S.P.

2. US District Court for Western District of Michigan – County Mask Mandate – Testified on 9/28/2021 in Restraining Order Hearing.

3. Filed Affidavits and Declarations in Over 12 Cases in State and Federal Courts in September (e.g., CA, FL, and NY).

DEFINITION OF INDUSTRIAL HYGIENE (AIHA)

“That science and art devoted to the anticipation, recognition, evaluation, and control of those environmental factors or stressors arising in or from the workplace, which may cause sickness, impaired health and well-being, or significant discomfort among workers or among the citizens of the community.”

Key Tenants of the Field of Industrial Hygiene (to stop or limit exposures):

1. Anticipation
2. Recognition
3. Evaluation
4. Control.

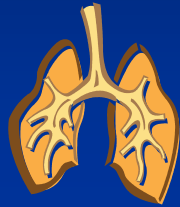
INDUSTRIAL HYGIENE (IH)

- **Field Associated with Exposure, PPE, and Warnings.**
- **Not Recognized by Much of the Public, Media, & Governmental Officials – Thus Media often rely on M.D.s Instead for Information on Controlling Exposures.**
- **Not Associated with Dentistry!**

EXPOSURE ROUTES

Exposure, in General, Can Occur from One of Four Primary Pathways – For COVID it is the Inhalation Path:

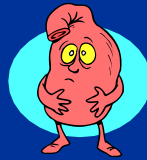
➤ Inhalation



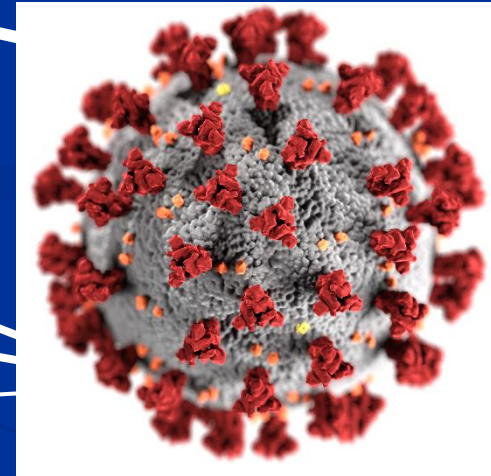
➤ Dermal



➤ Ingestion



➤ Intravenous.



EXPOSURE

Exposure is a function of 2 main parameters:

1. Concentrations – lower is better.

2. Time(s) – less time is better.

Distance – further away from source is better - sometimes.

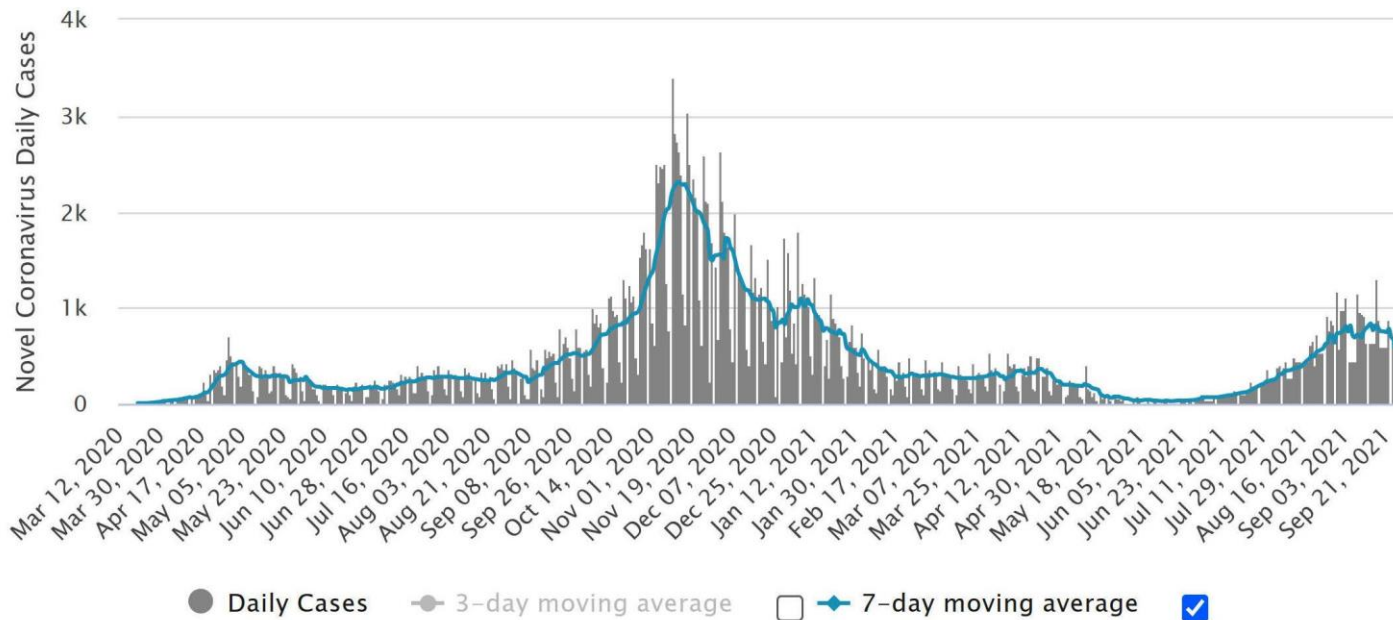
MACRO VIEW REGARDING MASKS

New York State – Disease Progression Curves - Cases

Daily New Cases in Nebraska

Daily New Cases

Cases per Day
Data as of 0:00 GMT+0



Looks Like Winter (More Time Indoors & Delta) Flu Curve; Masks – Would Expect Curve to Drop with Time!

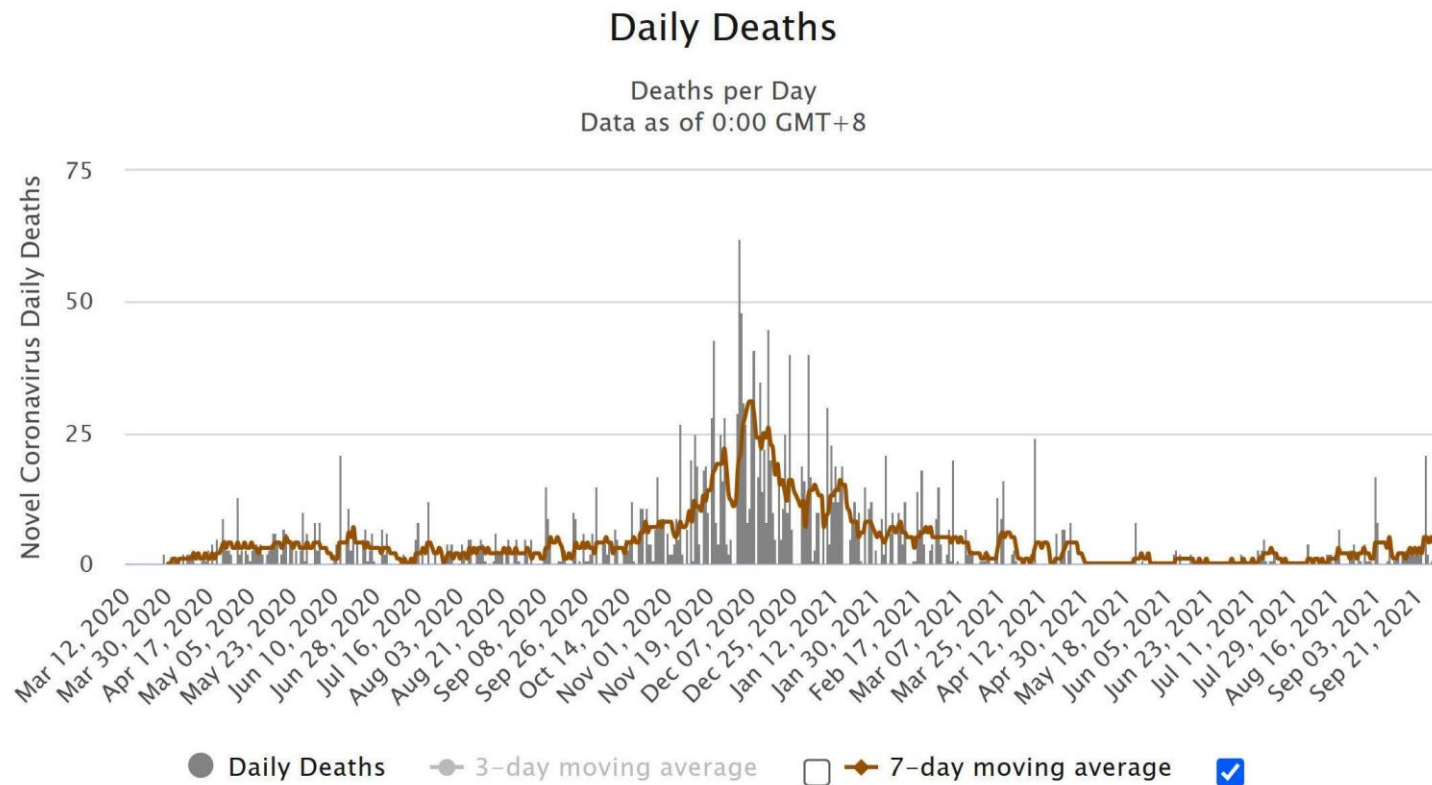
From: <https://www.worldometers.info/coronavirus/usa/nebraska/>

Downloaded: September 30, 2021

MACRO VIEW REGARDING MASKS

Nebraska – Disease Progression Curves - Deaths

Daily New Deaths in Nebraska



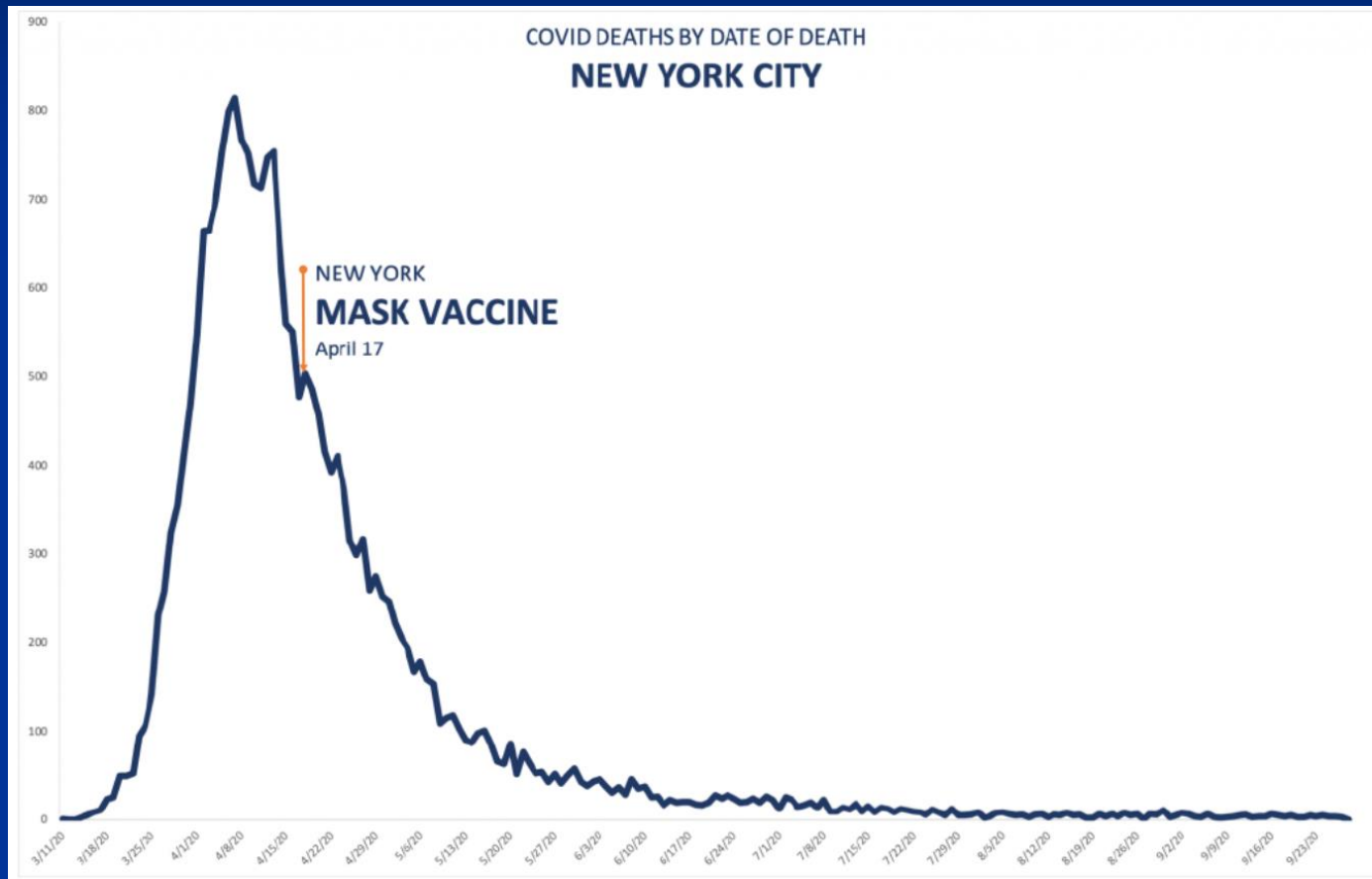
Again - Looks Like Winter (More Time Indoors) Flu Curve; Masks – Would Expect Curve to Drop with Time!

From: <https://www.worldometers.info/coronavirus/usa/nebraska/>

Downloaded: September 30, 2021

MACRO VIEW REGARDING MASKS

Other Places – Disease Progression Curves vs. Masks



From: <https://rationalground.com/mask-charts/>

Downloaded: September 28, 2021

MACRO VIEW REGARDING MASKS

Other Places – Disease Progression Curves vs. Masks



From: <https://rationalground.com/mask-charts/>

Downloaded: September 28, 2021

ONLY MAJOR DOUBLE BLIND MACRO MASK STUDY - DENMARK

Annals of Internal Medicine™
Original Research • 16 November 2020

Effectiveness of Adding a Mask Recommendation to Other Public Health Measures to Prevent SARS-CoV-2 Infection in Danish Mask Wearers FREE

A Randomized Controlled Trial

Henning Bundgaard, DMSc , Johan Skov Bundgaard, BSc ,
Daniel Emil Tadeusz Raaschou-Pedersen, BSc , Christian von Buchwald, DMSc ,
Tobias Todsén, MD , Jakob Boesgaard Norsk, MD , Mia M. Pries-Heje, MD,
Christoffer Rasmus Vissing, MD , Pernille B. Nielsen, MD, Ulrik C. Winslow, MD, Kamille Fogh, MD,
Rasmus Hasselbalch, MD , Jonas H. Kristensen, MD , Anna Ringgaard, PhD,
Mikkel Porsborg Andersen, PhD , Nicole Bakkegård Goecke, PhD , Ramona Trebbien, PhD ,
Kerstin Skovgaard, PhD , Thomas Benfield, DMSc , Henrik Ullum, PhD ,
Christian Torp-Pedersen, DMSc , Kasper Iversen, DMSc [View fewer authors](#) 

[Author, Article and Disclosure Information](#)

<https://doi.org/10.7326/M20-6817>

Eligible for CME Point-of-Care

**Wearing masks, statistically,
did not affect rates of COVID-19
infection.**

Bundgaard et al. Study - Denmark

**~6,000 participants; split w/ and wo/
surgical masks**

Results:

A total of 3030 participants were randomly assigned to the recommendation to wear masks, and 2994 were assigned to control; 4862 completed the study. Infection with SARS-CoV-2 occurred in 42 participants recommended masks (1.8%) and 53 control participants (2.1%). The between-group difference was $\times 0.3$ percentage point (95% CI, $\times 0.2$ to 0.4 percentage point; $P = 0.38$) (odds ratio, 0.82 [CI, 0.54 to 1.23]; $P = 0.33$). Multiple imputation accounting for loss to follow-up yielded similar results. Although the difference observed was not statistically significant, the 95% CIs are compatible with a 46% reduction to a 23% increase in infection.

Masking in Schools – Do They Work?

Oster, E., R. Jack, C. Halloran, J. School, and D. McLeod, COVID-19 Mitigation Practices and COVID-19 Rates in Schools: Report on Data from Florida, New York, and Massachusetts, COVID-19 School Response Dashboard - <https://www.medrxiv.org/content/10.1101/2021.05.19.21257467v1>

Statements on Wearing of Masks vs. No Masks*:

#1. Figure 4a shows the overall case rates in the three masking groups in Florida (staff and student masks required, only staff masks required, no masks required).

Figure 4b shows coefficients from regressions, which adjust for case rates. Note that in Figure 4b the omitted category is “Mask Mandate for All” so the coefficients and significance are interpreted as relative to that group.

***One of the few studies looking at impacts of masks vs. no masks as single cofounder in schools.**

Masking in Schools – Do They Work?

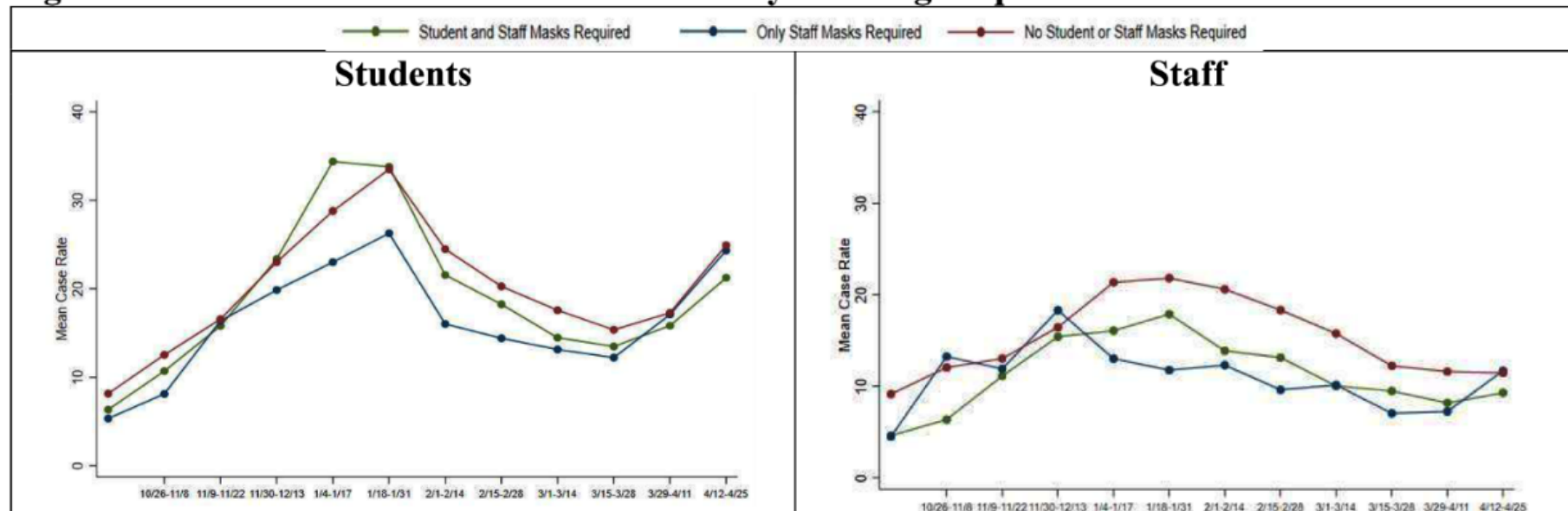
Statements on Wearing of Masks vs. No Masks – cont.:

2. In Figure 4a we see higher staff COVID-19 rates in areas without mask mandates for either students or staff. Student COVID-19 rates do not appear to vary with mask mandates.
3. The results in Figure 4b are similar, although we find that the differences for staff are not significant once we adjust for community rates and other demographics. Community case rates appear to be higher in areas without mask mandates in schools, likely reflecting a lack of mask mandates in general.
4. The regressions in Table 2 are consistent with the figures; staff rates are slightly higher in areas without any mask mandates, but these results are not significant at conventional levels and are small.

Masking in Schools – Do They Work?

Data on Wearing of Masks vs. No Masks – cont.:

Figure 4a. Mean Student and Staff Case Rates by Masking Requirements in Florida



Note. Florida masking practices are categorized into three groups: masks required for both students and staff, masks required for staff only, and no masks required for either students or staff. Case rates are reported as daily COVID-19 case rates per 100,000. Mean daily case rate is calculated by group per biweekly wave in the data. Means do not control for community case rates or population demographics.

Light Green Lines – Students and Staff Masked

Blue Lines – Staff Only Masks

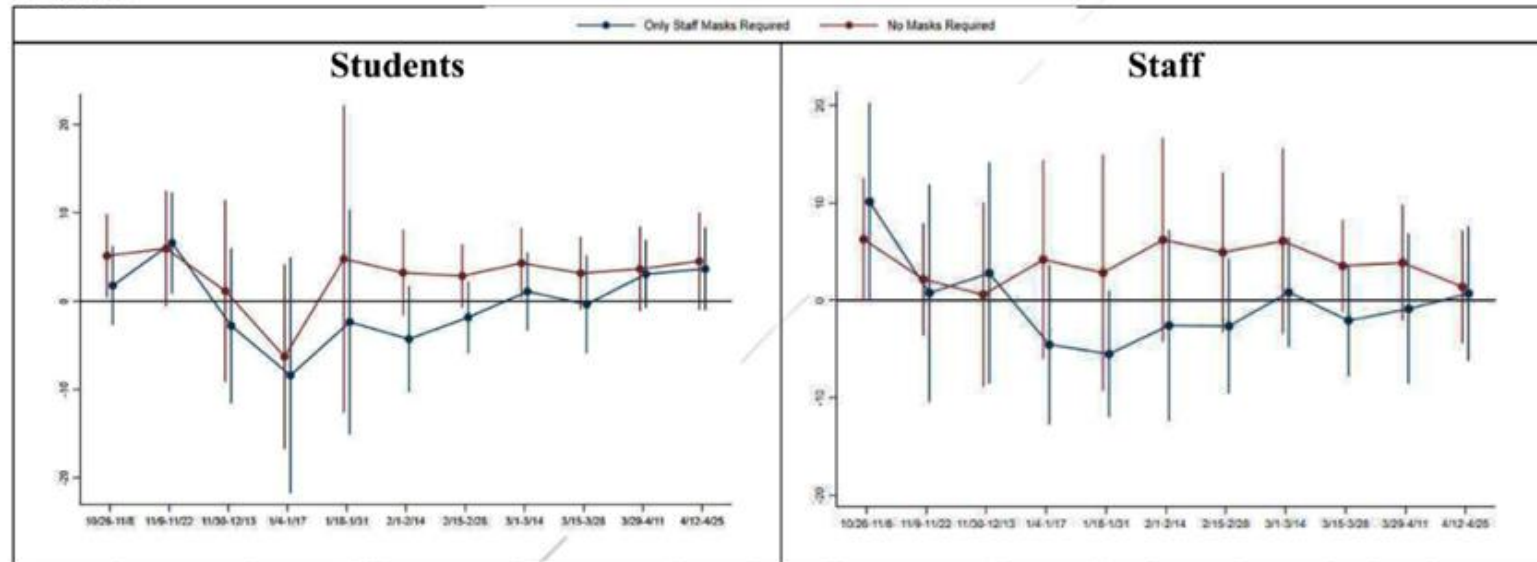
Red Lines – No Student or Staff Masks Required.

One of the few studies in schools to evaluate the effect of masks only on disease!
Essentially no Differences.

Masking in Schools – Do They Work?

Data on Wearing of Masks vs. No Masks – cont.:

Figure 4b. Regression Coefficients of Student and Staff Case Rates on Masking Requirements in Florida



Note. The regression coefficients are from regressions of masking groups (i.e. staff-only masks required and no masks required) interacted with each biweekly wave group on student and staff case rates. The comparison is masks required for both students and staff. Regressions control for community case rates, time fixed effects, racial demographics, density groups, ventilation upgrades, and school level. Regressions are weighted by total student enrollment and standard errors are clustered by school districts.

Light Green Lines – Students and Staff Masked

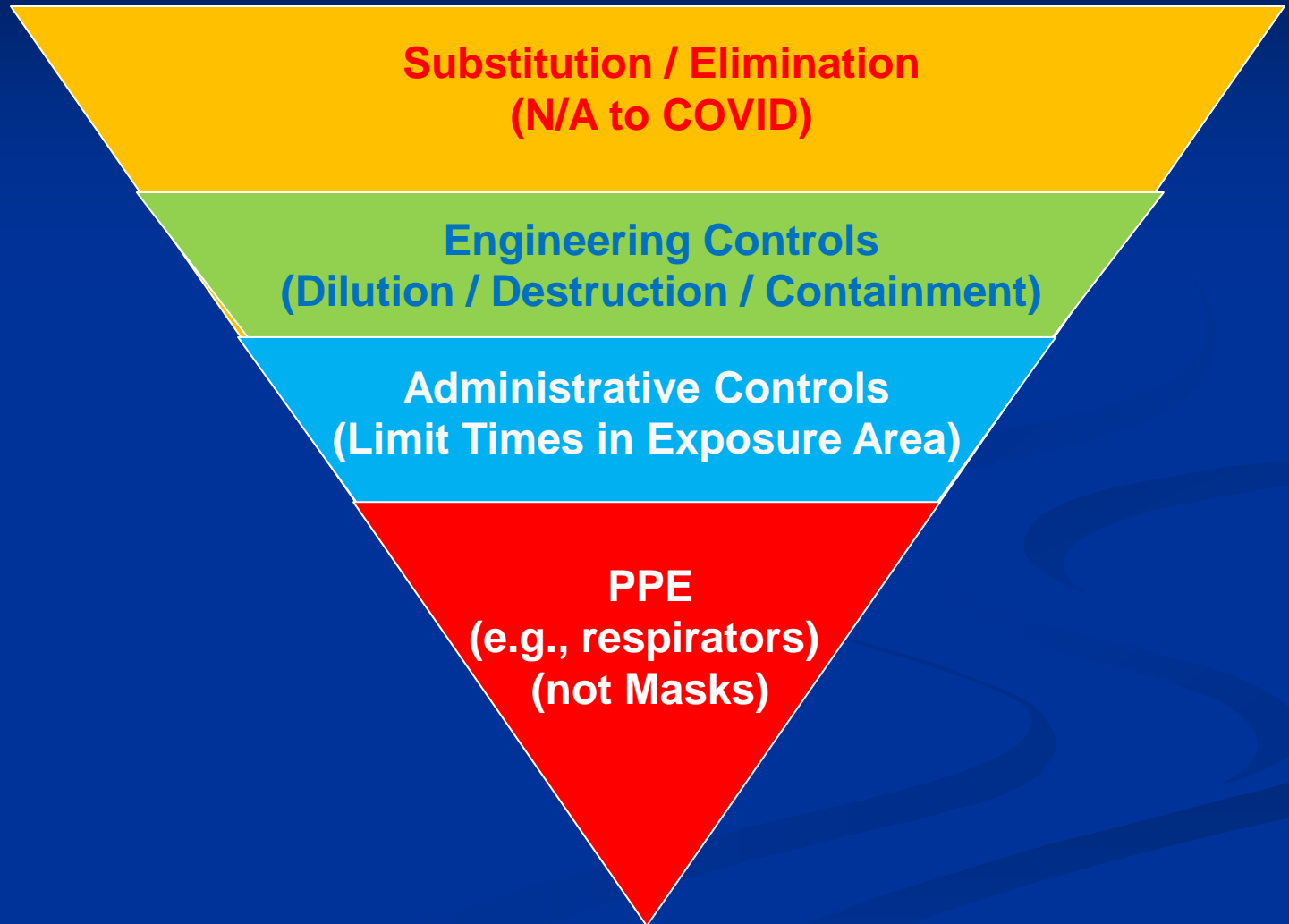
Blue Lines – Staff Only Masks

Red Lines – No Student or Staff Masks Required.

One of the few studies in schools to evaluate the effect of masks only on disease!
Essentially no Differences.

IH HIERARCHY OF CONTROLS – To Minimize Exposure(s)

Most Effective



Least Effective

Masks

SO WHERE ARE THE BOUNDARIES?

Not PPE – Cannot be Sealed



PPE – Can be Sealed



N-95



**Half Face
Respirator**

Masks are not Respirators: Terms often Conflated

Masks vs. PPE – What Does OSHA Say?

OSHA Confuses the Public – Says Wear Masks on Pg. 1 but on Pg. 6 says they are not protective.....

Additional Considerations for PPE

Interim guidance for specific types of workers and employers includes recommended PPE ensembles for various types of activities that workers may perform. In general:



- *PPE may be needed when engineering and administrative controls are insufficient to protect workers from exposure to SARS-CoV-2 or other workplace hazards and essential work operations must continue.*
- *If workers need respirators, they must be used in the context of a comprehensive respiratory protection program that meets the requirements of OSHA's Respiratory Protection standard (29 CFR 1910.134) and includes medical exams, fit testing, and training.*
 - ***Surgical masks are not respirators and do not provide the same level of protection to workers as properly-fitted respirators. Cloth face coverings are also not acceptable substitutes for respirators.***

Masks are not Respirators: Terms often Conflated – Leak around edges and cannot be fit tested. CDC says the same!

Masks vs. PPE – CDC Says the Same Thing

CDC Also Confuses the Public – Says Wear Masks but says...

Understanding the Difference

	 Surgical Mask	 N95 Respirator
Testing and Approval	Cleared by the U.S. Food and Drug Administration (FDA)	Evaluated, tested, and approved by NIOSH as per the requirements in 42 CFR Part 84
Intended Use and Purpose	Fluid resistant and provides the wearer protection against large droplets, splashes, or sprays of bodily or other hazardous fluids. Protects the patient from the wearer's respiratory emissions.	Reduces wearer's exposure to particles including small particle aerosols and large droplets (only non-oil aerosols).
Face Seal Fit	Loose fitting	Tight fitting
Fit Testing Requirement	No	Yes
User Seal Check Requirement	No	Yes. Required each time the respirator is donned (put on)
Filtration	Does NOT provide the wearer with a reliable level of protection from inhaling smaller airborne particles and is not considered respiratory protection	Filters out at least 95% of airborne particles including large and small particles
Leakage	Leakage occurs around the edge of the mask when user inhales	When properly fitted and donned, minimal leakage occurs around edges of the respirator when user inhales
Use Limitations	Disposable. Discard after each patient encounter.	

MASK

vs.

RESPIRATOR

Does NOT provide the wearer with a reliable level of protection from inhaling smaller airborne particles and is not considered respiratory protection

Filters out at least 95% of airborne particles including large and small particles

Leakage occurs around the edge of the mask when user inhales

When properly fitted and donned, minimal leakage occurs around edges of the respirator when user inhales

Masks Not Good for Fire Smoke Particles but OK for Small COVID-19 Aerosols?

Cloth masks will not protect you from wildfire smoke.

Cloth **masks** that are used to slow the spread of COVID-19 by blocking respiratory droplets offer little protection against wildfire smoke. They might not catch small, harmful particles in smoke that can harm your health.

N95 and KN95 respirators can provide protection from wildfire smoke and from getting and spreading COVID-19. CDC does not recommend the use of N95 respirators in non-healthcare settings because N95 respirators should be reserved for health care workers. **KN95 respirators** are commonly made in China and are similar to N95 masks commonly used in the United States. Look for KN95 masks that meet **requirements** similar to those set by CDC's National Institute for Occupational Safety and Health (NIOSH) for respirators.

Particles from smoke tend to be very small, with a size range near the wavelength of visible light (0.4–0.7 micrometers) – Cloth masks will not work.

But COVID-19 Particles are ~0.1 microns (micrometers) – smaller sized particles but will work.

WHAT? – Does this make any sense?

CLOTH MASKS NOT EFFECTIVE BUT STILL USE THEM

Effectiveness of Cloth Masks for Protection Against Severe Acute Respiratory Syndrome Coronavirus 2 by Abrar A. Chughtai, Holly Seale, and C. Raina Macintyre, 2020 (Published by CDC)

States: “In 2015, we conducted a randomized controlled trial to compare the efficacy of cloth masks with that of medical masks and controls (standard practice) among healthcare workers in Vietnam (4). Rates of infection were consistently higher among those in the cloth mask group than in the medical mask and control groups. This finding suggests that risk for infection was higher for those wearing cloth masks.”

Yet, they say use mask because: “The *primary transmission routes* for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) are thought to be inhalation of respiratory droplets and close contact.”

NO, Not Surfaces or Droplets, but Aerosols!

Some Very New Analyses Regarding Masks

AIHA GUIDANCE DOCUMENT

American Industrial Hygiene Association (AIHA)



HEALTHIER WORKPLACES | A HEALTHIER WORLD

Reducing the Risk of COVID-19 Using Engineering Controls

Guidance Document

aiha.org

Version 4 | September 9, 2020

September 9, 2020 Guidance on COVID-19 from AIHA

AIHA VERSION – Hierarchy of Controls

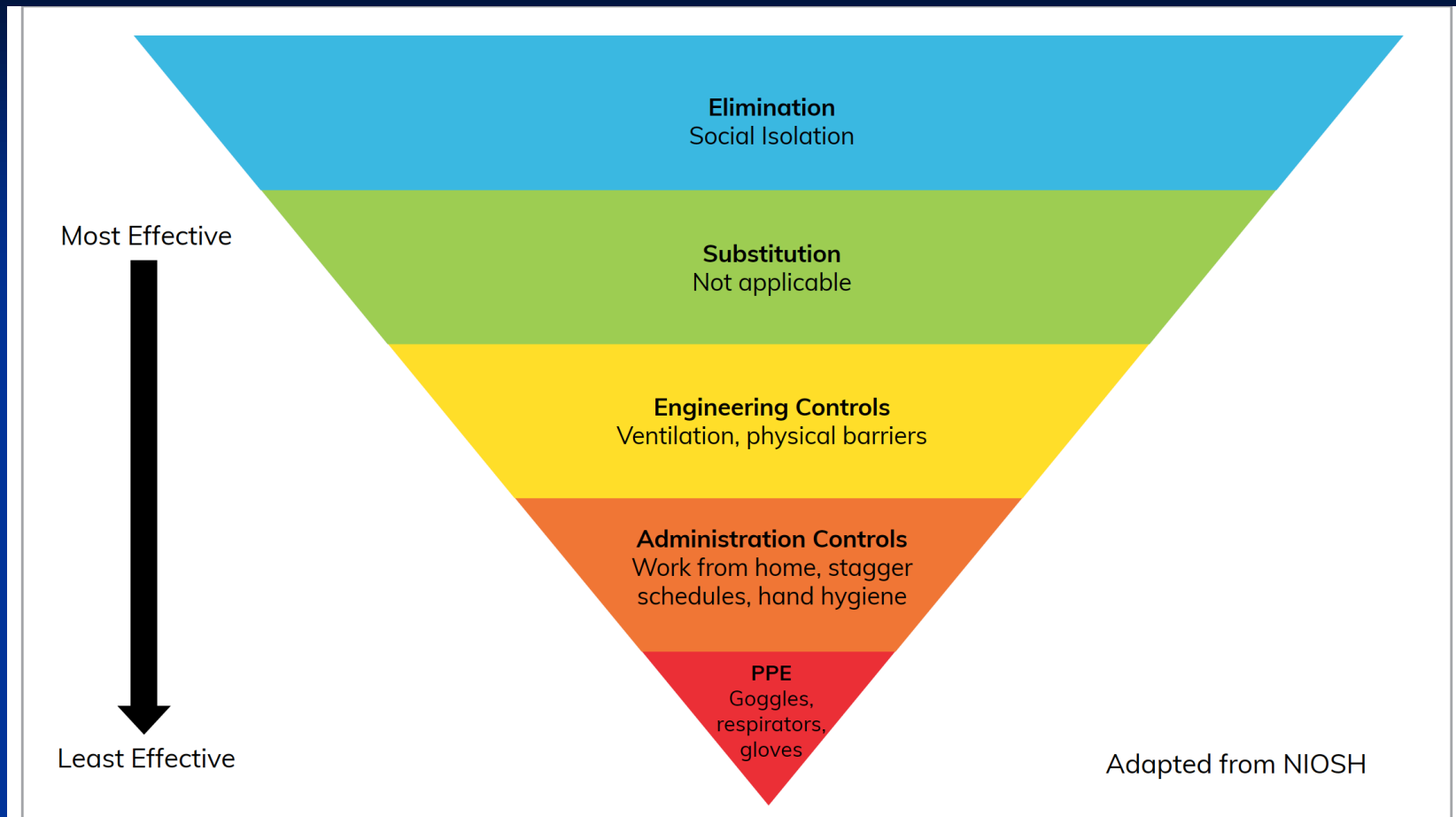


Figure 1: Applying the Hierarchy of Controls for COVID-19.



AIHA – Relative Risk Reductions

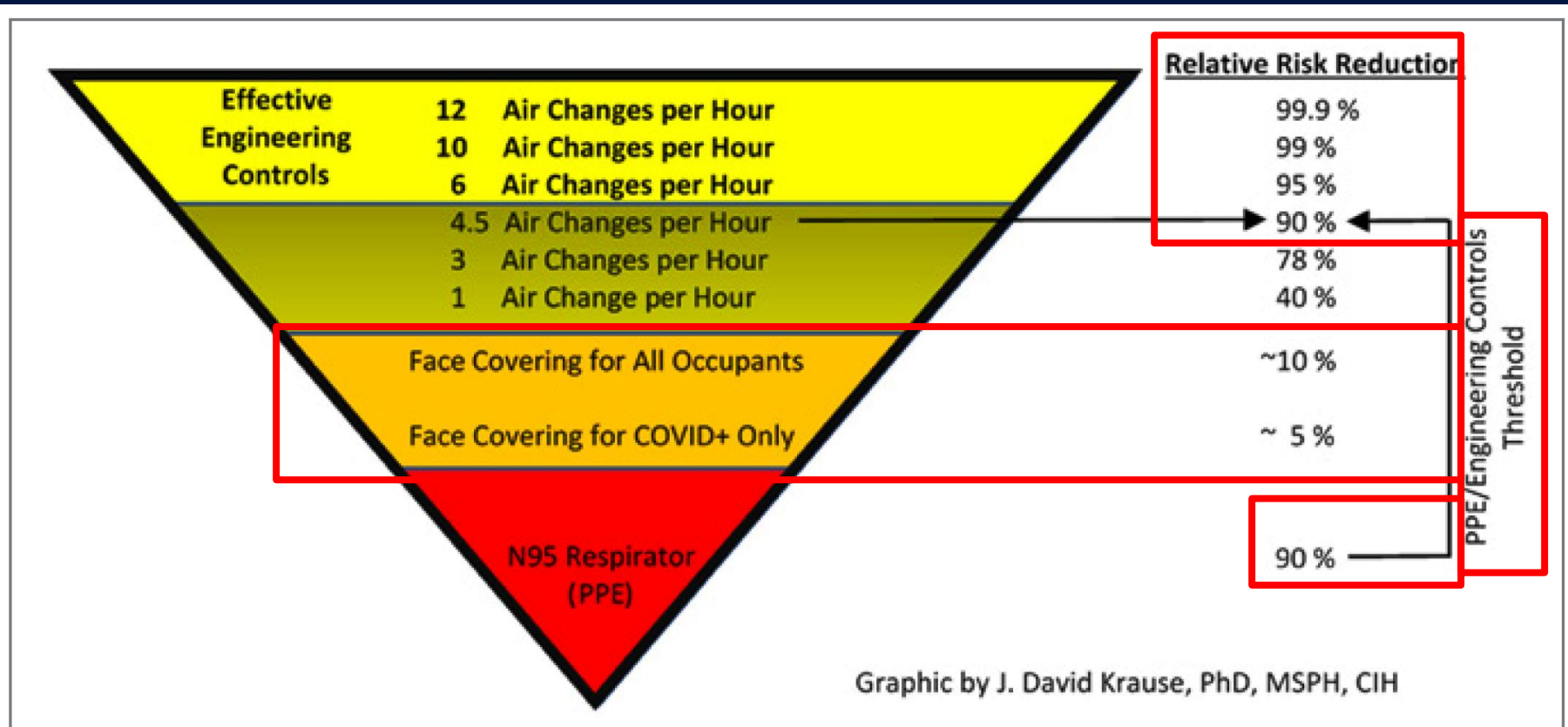


Figure 2*

*To learn how the relative risk reduction estimates were derived for Figure 2, download the [SUPPLEMENT for Reducing the Risk of COVID-19 using Engineering Controls](#).



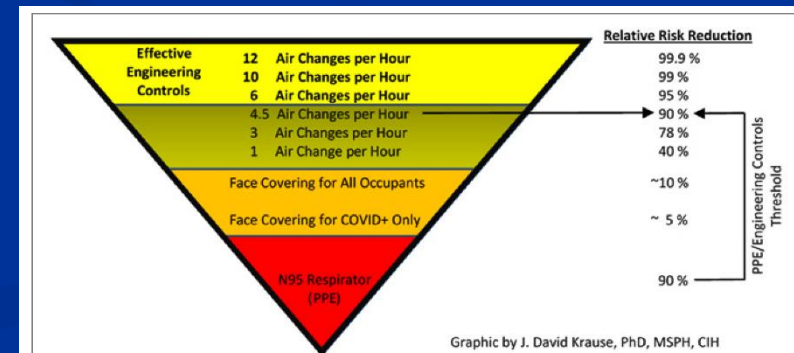
AIHA – What Does This Mean?

Exposure Controls Must Have a Relative Risk (RR) Reduction Threshold of 90%!

Masks only have RR of ~5% to ~10% and Do Not Meet 90% Threshold.

≥ 4.5 ACH – Ventilation has RR of 90+%.

N-95s – Maybe Not!



AIHA – Mask Remarks

“While not evaluated in this study, face seal leakage is further known to decrease the respiratory protection offered by fabric materials. Aerosol penetration for face masks made with loosely held fabric materials occurs in both directions (inhaled and exhaled). Due to their loose fitting nature and the leakage that occurs even when a face mask is properly worn, a modifying factor of 25% was applied. (???)

AIHA – Mask Remarks

“The impact of typical leakage and frequent non-compliance with proper use and wear, is the basis for a generous estimate of 5-10% relative risk reduction for face masks and cloth face coverings.”

AIHA – Concluding Remarks

...In light of the limited level of relative risk reduction offered by face coverings and masks the AIHA has recommended engineering controls be used to reduce the risk of exposure in indoor environments,
which is anticipated to reduce the transmission of disease, even in non-healthcare settings.

MERV \geq 17 Filtration Systems Recommended.

Shah et al., 2021 – Effectiveness of Masks

Physics of Fluids

ARTICLE

scitation.org/journal/phf

Experimental investigation of indoor aerosol dispersion and accumulation in the context of COVID-19: Effects of masks and ventilation

Cite as: Phys. Fluids **33**, 073315 (2021); doi: [10.1063/5.0057100](https://doi.org/10.1063/5.0057100)

Submitted: 17 May 2021 · Accepted: 2 July 2021 ·

Published Online: 21 July 2021







View Online



Export Citation



CrossMark

Yash Shah,  John W. Kurelek,  Sean D. Peterson,  and Serhiy Yarusevych^{a)} 

Shah et al., 2021 – Effectiveness of Masks

Abstract: Filtration Efficiencies:

- High-efficiency masks (R95 & KN95): 60% and 46% respectively.
- Cloth Masks (10%).
- Surgical masks (12%).

Not Conservative Because:

- Used 1 μm particles (COVID-19 $\sim 0.1 \mu\text{m}$).
- Sealed mask – no gaps – “Hole(y) Mask” Podcast.

Shah et al., 2021 – Effectiveness of Masks

Abstract: Engineering Controls Better:

The results also suggest that, while higher ventilation capacities are required to fully mitigate aerosol build-up, even relatively low air-change rates (2 h^{-1}) lead to lower aerosol build-up compared to the best performing mask in an unventilated space.

Note the use of the term “aerosol.”

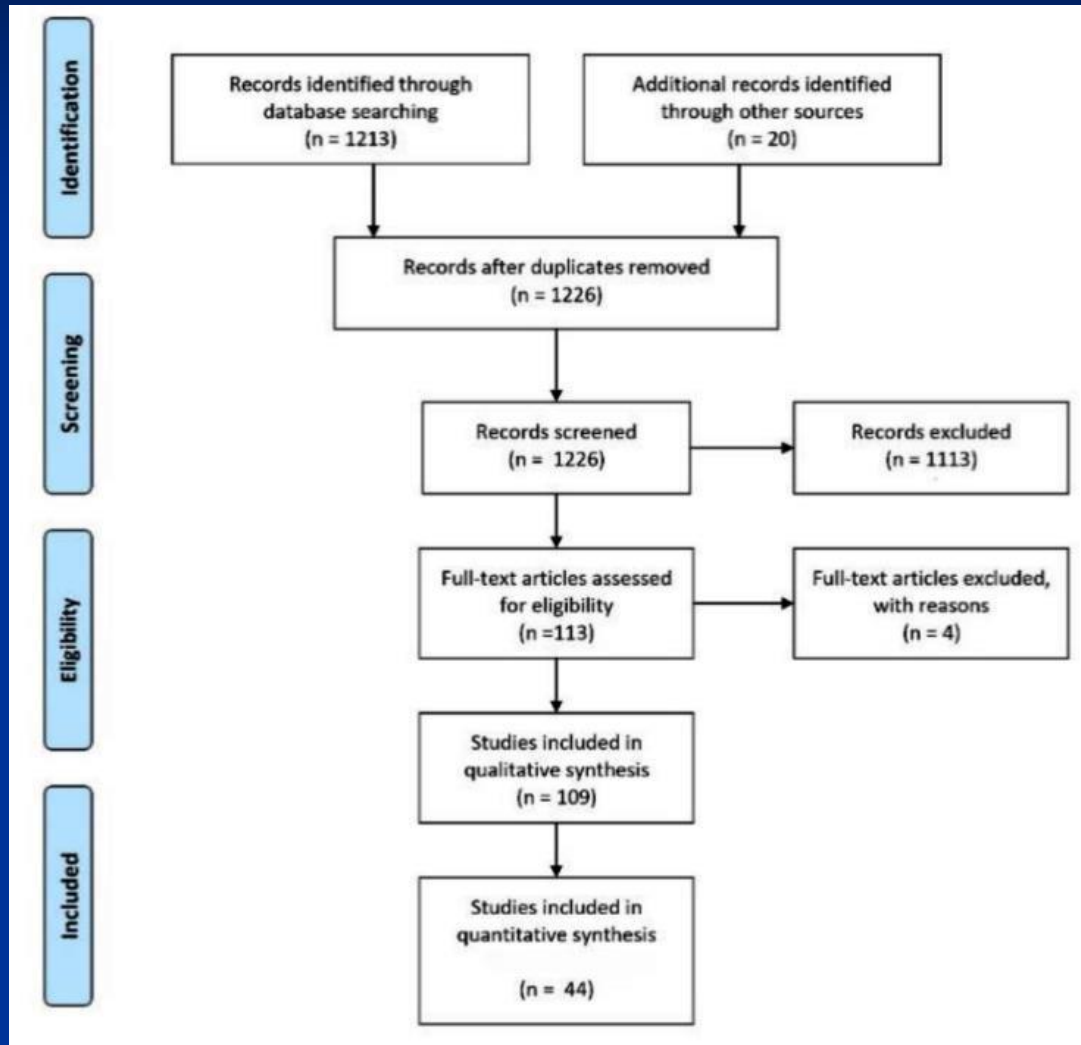
OTHER NEGATIVE EFFECTS OF WEARING MASKS

Review

Is a Mask That Covers the Mouth and Nose Free from Undesirable Side Effects in Everyday Use and Free of Potential Hazards?

Kai Kisielinski ¹, Paul Giboni ², Andreas Prescher ³, Bernd Klosterhalfen ⁴, David Graessel ⁵, Stefan Funken ⁶, Oliver Kempfski ⁷ and Oliver Hirsch ^{8,*}

KISIELINSKI ET AL, 2021 NEGATIVE EFFECTS OF WEARING MASKS



1,226 Studies Considered;

Reduced to:

109 Qualitative &

44 Quantitative Studies

OTHER NEGATIVE EFFECTS OF WEARING MASKS

Increased risk of adverse effects when using masks:

Internal diseases

COPD
Sleep Apnea Syndrome
advanced renal Failure
Obesity
Cardiopulmonary Dysfunction
Asthma

Psychiatric illness

Claustrophobia
Panic Disorder
Personality Disorders
Dementia
Schizophrenia
helpless Patients
fixed and sedated Patients

Neurological Diseases

Migraines and Headache Sufferers
Patients with intracranial Masses
Epilepsy

Pediatric Diseases

Asthma
Respiratory diseases
Cardiopulmonary Diseases
Neuromuscular Diseases
Epilepsy

ENT Diseases

Vocal Cord Disorders
Rhinitis and obstructive Diseases

Dermatological Diseases

Acne
Atopic

Occupational Health Restrictions

moderate / heavy physical Work

Gynecological restrictions

Pregnant Women

Figure 5. Diseases/predispositions with significant risks, according to the literature found, when using masks. Indications for weighing up medical mask exemption certificates.

OTHER NEGATIVE EFFECTS OF WEARING MASKS

Abstract: Many countries introduced the requirement to wear masks in public spaces for containing SARS-CoV-2 making it commonplace in 2020. Up until now, there has been no comprehensive investigation as to the adverse health effects masks can cause. The aim was to find, test, evaluate and compile scientifically proven related side effects of wearing masks. For a quantitative evaluation, 44 mostly experimental studies were referenced, and for a substantive evaluation, 65 publications were found. The literature revealed relevant adverse effects of masks in numerous disciplines. In this paper, we refer to the psychological and physical deterioration as well as multiple symptoms described because of their consistent, recurrent and uniform presentation from different disciplines as a Mask-Induced Exhaustion Syndrome (MIES). We objectified evaluation evidenced changes in respiratory physiology of mask wearers with significant correlation of O₂ drop and fatigue ($p < 0.05$), a clustered co-occurrence of respiratory impairment and O₂ drop (67%), N95 mask and CO₂ rise (82%), N95 mask and O₂ drop (72%), N95 mask and headache (60%), respiratory impairment and temperature rise (88%), but also temperature rise and moisture (100%) under the masks. Extended mask-wearing by the general population could lead to relevant effects and consequences in many medical fields.

RESPIRATORS CAN BE FIT TESTED AND SEALED

Under OSHA, Respirators Intended as Respiratory Protection
(29 CFR 1910.134)

Worst



Best



N-95 (Worst)



1/2 Face/
Full Face



Air

Purifying



Supplied

Air

EVEN SUPPLIERS OF N95s WARN AGAINST USE FOR AEROSOLS & INFECTIOUS DISEASE

Use For

Particles such as those from grinding, sanding, sweeping, sawing, bagging, or processing minerals, coal, iron ore, flour, metal, wood, pollen, and certain other substances. Liquid or non-oil based particles from sprays that do not also emit oil aerosols or vapors. Follow all applicable local regulations. For additional information on 3M use recommendations for this class of respirator please consult the 3M Respirator Selection Guide found on the 3M Personal Safety Division website at www.3M.com/respiratorselector or call 1-800-243-4630 in U.S.A. In Canada call 1-800-267-4414.

Do Not Use For

Do not use for gases and vapors, oil aerosols, asbestos, or sandblasting; particulate concentrations that exceed either 10 times the occupational exposure limit or applicable government regulations, whichever is lower. In the U.S., do not use when the Occupational Safety and Health Administration (OSHA) substance specific standards, such as those for, arsenic, cadmium, lead in the construction industry, or 4,4'-methylene dianiline (MDA), specify other types of respiratory protection. This respirator does not supply oxygen.

Biological Particles

This respirator can help reduce inhalation exposures to certain airborne biological particles (e.g. mold, *Bacillus anthracis*, *Mycobacterium tuberculosis*, etc.) but cannot eliminate the risk of contracting infection, illness or disease. OSHA and other government agencies have not established safe exposure limits for these contaminants.

Even an N95 Respirator is not recommended for larger asbestos particles, aerosols, or to stop illness or disease.

How can a mask do this? It CANNOT.

IMPORT
Before use, in

Use For
Particles such
metal, wood,
aerosols or v.
class of respi
www.3M.com

Do Not U
Do not use it
times the oc
when the Oc
cadmium, le
This respirat

Biologica
This respirat
Mycobacteri
government

Use Instr

1. Failure t
all times
2. In the oc
meeting ap
applicat
require
3. The part
4. Leave it
5. Store th
6. Inspect
for signs
disposal
prior to
no dam
consider
7. Conduct
seal, do
8. Dispose

Use Limi

1. This respirator does not supply oxygen and is not to be used in atmospheres containing less than 19.5% oxygen.
2. Do not use when concentrations of contaminants are immediately dangerous to life or health, are unknown or when concentrations exceed 10 times the permissible exposure limit (PEL) or according to specific OSHA standards or applicable government regulations, whichever is lower.
3. Do not alter, wash, abuse or misuse this respirator.
4. Do not use with beards or other facial hair or other conditions that prevent a good seal between the face and the sealing surface of the respirator.
5. Respirators can help protect your lungs against certain airborne contaminants. They will not prevent entry through other routes such as the skin, which would require additional personal protective equipment (PPE).
6. This respirator is designed for occupational/professional use by adults who are properly trained in their use and limitations. This respirator is not designed to be used by children.
7. Individuals with a compromised respiratory system, such as asthma or emphysema, should consult a physician and must complete a medical evaluation prior to use.
8. When stored in accordance with temperature and humidity conditions specified the product may be used until the "use by" date specified on packaging.

Storage Conditions and Shelf Life

Before use, store respirators in the original packaging, away from contaminated areas, dust, sunlight, extreme temperatures, excessive moisture and damaging chemicals. When stored in accordance with temperature and humidity conditions specified the product may be used until the "use by" date specified on packaging. Always inspect product and conduct a user seal check before use as specified in these User Instructions. If you cannot achieve a proper seal, do not use the respirator.



End of Shelf Life
Use respirators before the "use by" date specified on packaging



Storage Temperature Range
-20°C (-4°F) to +30°C (+86°F)

OSHA 29 CFR 1910.134 – Respiratory Protection Standard (RPS)

<u>OSHA 1910.134 RPS Parameters</u>	<u>Mask</u>	<u>Respirator</u>
Medical Clearance to Wear	No	Yes
Ability to Wear Facial Hair – Beard	Yes	No
Initial Fit Test Requirement	No	Yes
Annual Requirement to Fit Test	No	Yes
Change-out Criteria for Filter/Cartridge	No	Yes
Training on Use of Mask/Respirator	No	Yes
Training on Storage of Mask/Resp.	No	Yes
Audit of Effectiveness of Program	No	Yes

CONCLUSION: Masks do not meet key OSHA RPS Requirements!

CDC vs. Petty

CDC:

Surfaces → *Droplets* → *Aerosols?*

2020

2021

Petty:

Aerosols → *Aerosols* → *Aerosols*

It's Always Been About the Little Guys (Aerosols - $< 5 \mu\text{m}$)

RECALL SEEING DUST IN THE AIR



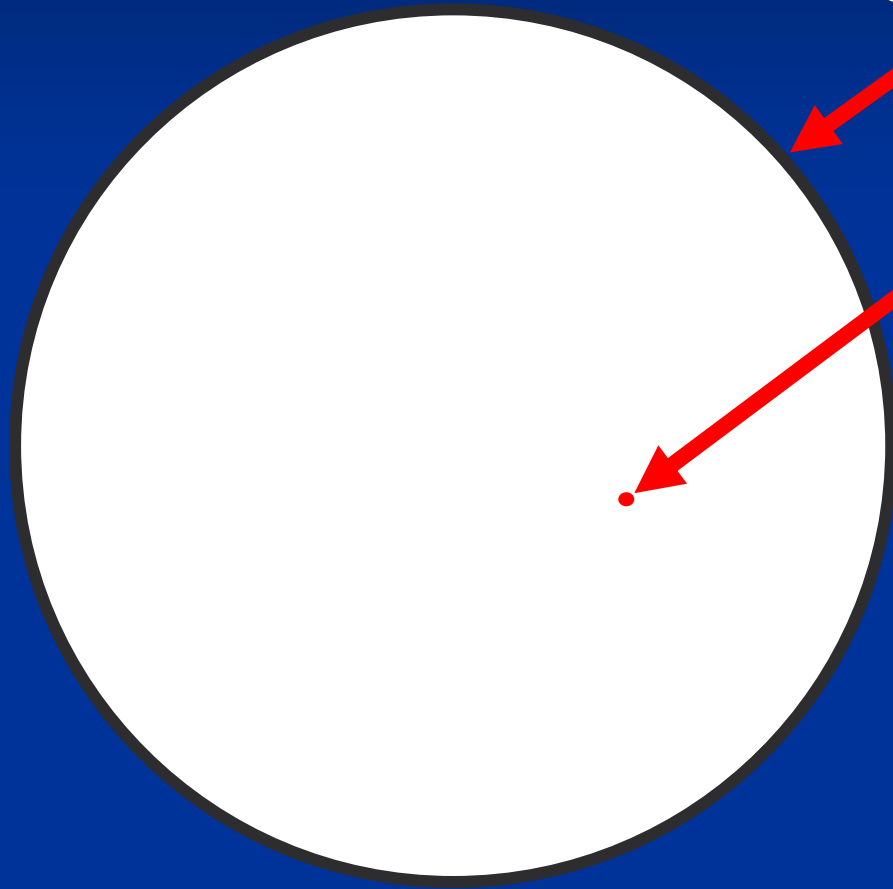
Visible Dust in Sunlight: $>50\text{ }\mu\text{m}$;

~500 times larger than COVID-19



How Big is a Micron vs. Human Hair Diameter?

**Black Ring is Cross Section
of Human Hair**



**1 Micron – Small Red Dot
COVID – 1/10 Micron**


~40,000 times smaller in area

*& ~1,000 times smaller in diameter
than the cross-section of human hair.*

Can you get a human hair past the side of your mask?

RELATIVE SIZES OF PARTICLES


Thickness of Human Hair:
~100 μm



100 Microns-
Strand of human
hair



10 Microns-
Size of typical dust mite



50 Microns-
Smallest size the
human eye can see

100 Microns- Thickness of a sheet of
standard paper

Visible Dust: >50 μm ;

Thickness of Paper:
~100 μm

LITTLE GUYS vs. BIG GUYS

“Big Guys” are Droplets: >5 to $10\text{ }\mu\text{m}$

VS.

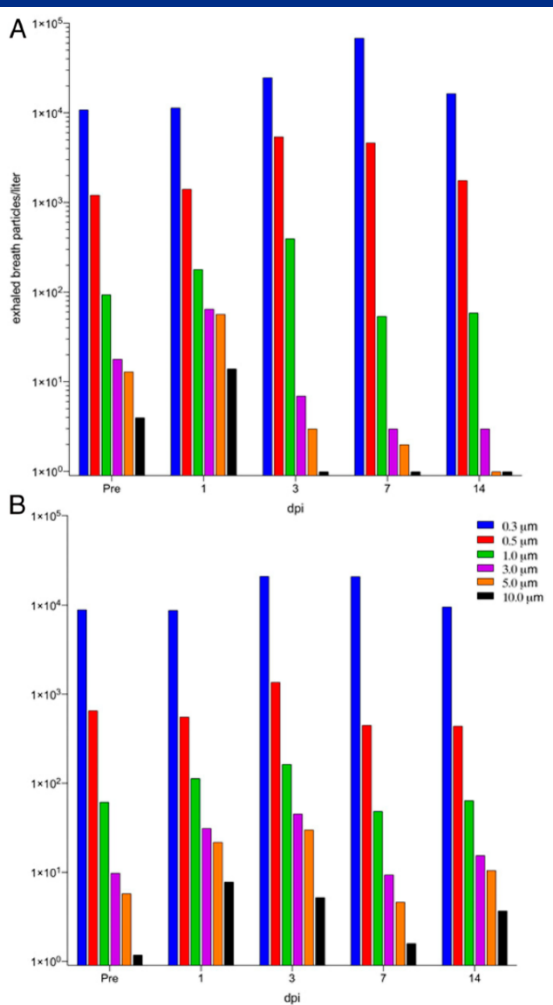


“Little Guys” are Aerosols: $\leq 5\text{ }\mu\text{m}$

Little guys are more prevalent and problematic.

Edwards et al. – 2/23/2021

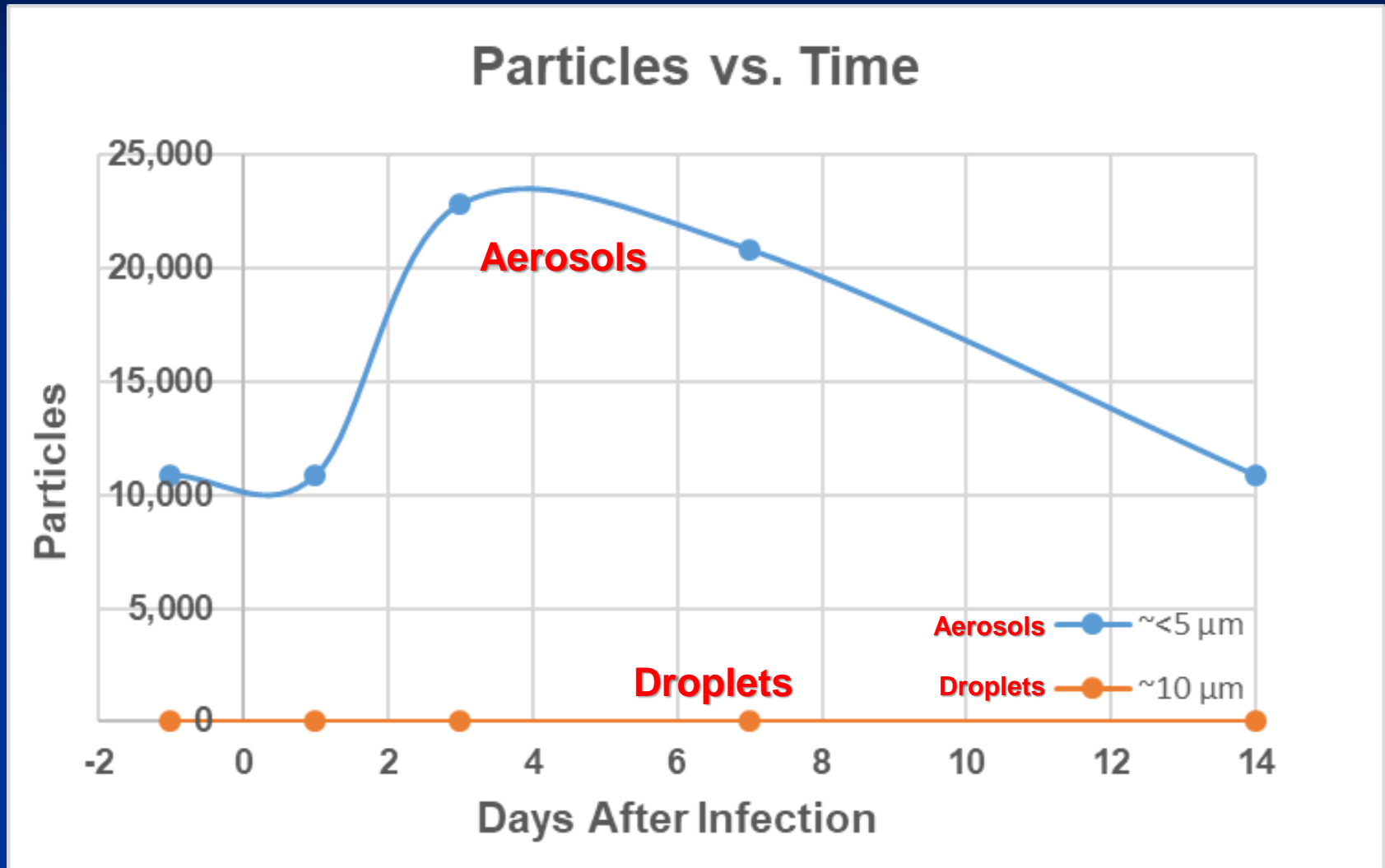
Data Presented by Size – in Colored Bars



Aerosols ($\leq 5 \mu\text{m}$)

Droplets (10 μm)

Edwards et al. – Data Simplified



Edwards et al. – Data Simplified

>99.9% Particles were Aerosols (small guys)

	Aerosols	Droplets	% Aerosols
Day After Infection	$\sim \leq 5 \mu\text{m}$	$\sim 10 \mu\text{m}$	% Small
-1	10,898	1.5	99.99%
1	10,900	9	99.92%
3	22,847	7	99.97%
7	20,847	3	99.99%
14	10,870	6	99.94%

Proceedings from the National Academy of Sciences Press – Edwards et al. – 2/23/2021

CONCLUSIONS FROM THE PAPER:

Our finding that the proportion of *small respiratory droplets (i.e., aerosols) [were the majority of particles exhaled in all subjects]*....

There may be an elevated risk of the ***airborne transmission of SARS-CoV-2 by way of the very small droplets that transmit through conventional masks and traverse distances far exceeding the conventional social distance of 2 m (~7').***

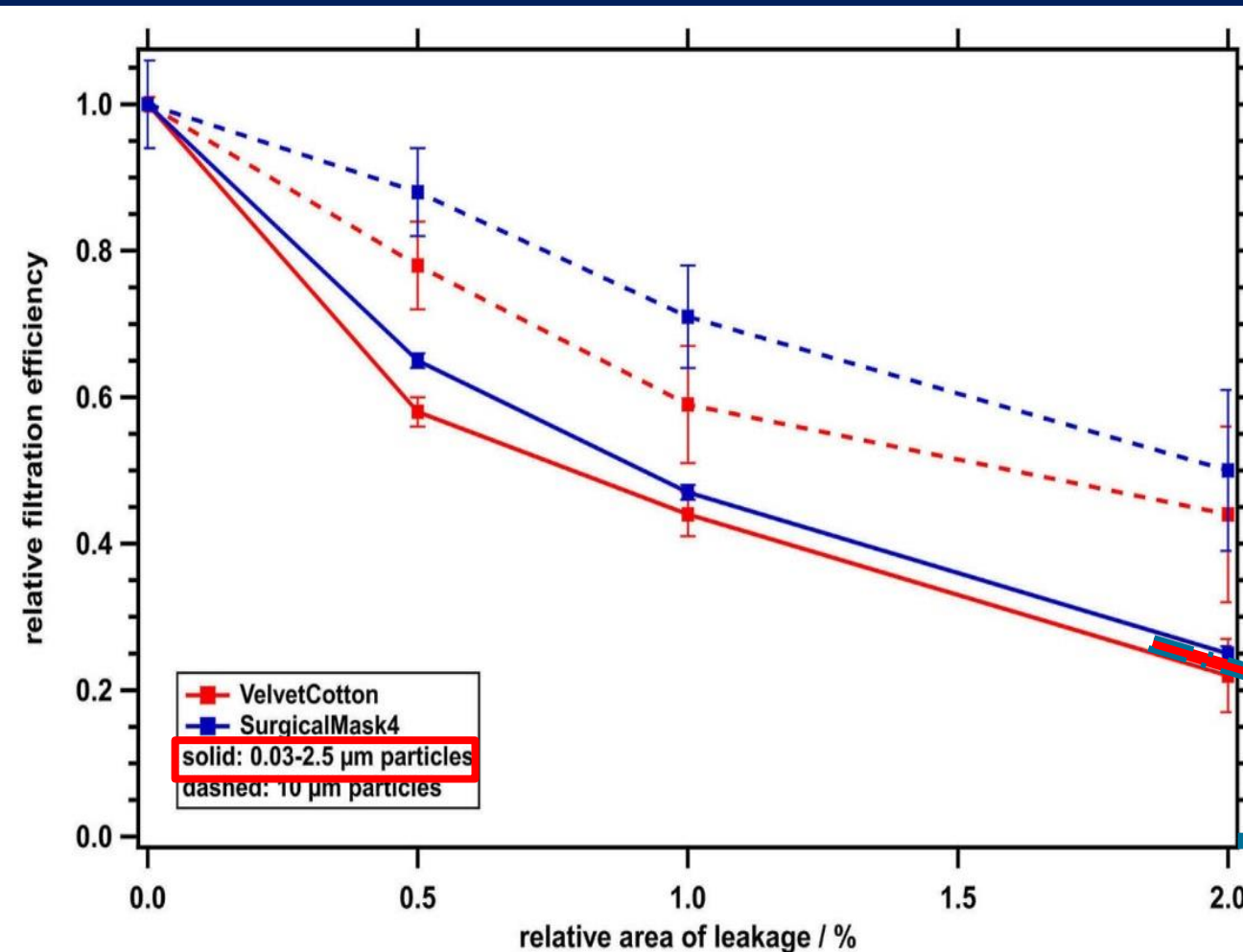
Exhaled aerosol numbers appear to be not only an indicator of disease progression, but ***a marker of disease risk in non-infected individuals.***

Edwards et al. – 2/23/2021

Conclusions

Our finding that the proportion of small respiratory droplets (i.e., aerosols) [were the majority of particles exhaled in all subjects]...

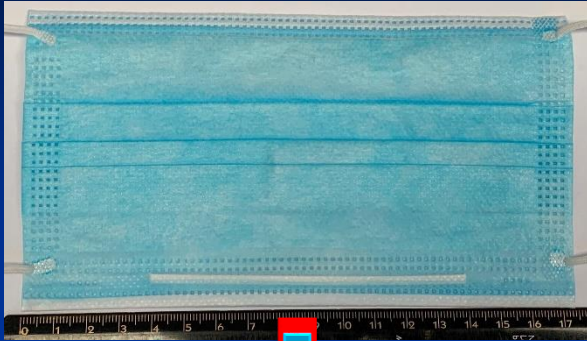
Leakage % (% of Mask Area with Hole in It) and Mask Reduction in Mask Effectiveness



*Based on this work,
at ~3% Open Area,
Cloth Mask
Effectiveness
Goes to Zero!*



ONE MAN'S SPIRIT AIRLINES MASK



Mask Area: 9.5 cm x
17.4 cm = 165.3 cm²



Nose Leak Area: 2 x
7.28 cm² = 14.56 cm²

Nose and Cheek Gaps
– Two Sides



Cheek Leak Area: 2
x 0.45 cm² = 0.90 cm²

Total Leak Area – 4 areas: 15.46 cm²

% Leak Area: (15.46/165.3) x 100 = 9.35%; Effectiveness “0”

Unmasking the surgeons: the evidence base behind the use of facemasks in surgery, 2015

Zhou, Sivathondan, and Handa

Why were masks used by Surgeons?

- 1. Facemasks have long been thought to confer protection to the patient from wound infection and contamination from the operating surgeon and other members of the surgical staff.**
- 2. More recently, protection of the theatre staff from patient-derived blood/bodily fluid splashes has also been offered as a reason for their continued use.**

“However, overall there is a lack of substantial evidence to support claims that face masks protect either patient or surgeon from infectious contamination.”

SMALL PARTICLES TAKE A LONG TIME TO FALL FIVE FEET IN STILL AIR



SMALL PARTICLES TAKE A LONG TIME TO FALL FIVE FEET IN STILL AIR

Stokes Law – How Fast Do Small Particles Fall?

$$V_s = 0.0052 * \text{Specific Gravity} * \text{Diameter}^2$$

Where:

V_s = Falling velocity in ft./min.

Specific Gravity – Density of the particle – virus is ~1.42

Diameter – Diameter of the particle in microns for particles <100 microns

Stokes Law (see Industrial Ventilation Workbook, D. Jeff Burton, 4th edition, 1997)

See also: [https://www.thelancet.com/pdfs/journals/lanres/PIIS2213-2600\(20\)30323-4.pdf](https://www.thelancet.com/pdfs/journals/lanres/PIIS2213-2600(20)30323-4.pdf) – Fennelly - Particle sizes of infectious aerosols: implications for infection control – Lancet – Sept. 2020.

SMALL PARTICLES TAKE A LONG TIME TO FALL FIVE FEET IN STILL AIR

Droplets fall fast – 0.1 to 10 minutes

Particle Size (μm)	Time to Fall 5' (minutes)
10	9.6
25	1.5
100	0.1

Assumes still air; in moving air times would be even longer.

SMALL PARTICLES TAKE A LONG TIME TO FALL FIVE FEET IN STILL AIR

Aerosols Fall Slowly: 0.03 to 59 days

Particle Size (μm)	Time to Fall 5' (days)	Type of Particle
0.09	58.9	Aerosol
0.12	46.4	
0.2	16.7	
1	0.67	
5	0.027	

COVID

COVID-19 Fall Very Slowly: 46.4 to 58.9 days

Assumes still air; in moving air times would be even longer.

WHY ARE AEROSOLS – SMALL PARTICLES SO IMPORTANT?

1. Aerosols (very small particles - <5 microns) can stay suspended for hours to days.
2. Since they stay suspended for so long, they can actually *accumulate* in concentration in indoor air rather than dropping out if you assumed they were droplets.
3. This effectively renders the 6' rule useless. This also renders masks essentially useless; they do not filter out aerosols and they cannot be fitted (gaps around the edges).

REAL INDUSTRIAL HYGIENE SOLUTIONS

EXPOSURE CONTROL – DILUTION BY VENTILATION OR MAXIMUM FRESH AIR

Dilution of Virus by Dilution and/or Ventilation – More Fresh Air!

- *Spend More Time or Meet Outdoors* – condition of maximum fresh air and dilution of virus – avoid indoors.
- Ventilation – Residential and Commercial – Crack open windows or doors – especially with company.



EXPOSURE CONTROL – DILUTION BY VENTILATION OR MAXIMUM FRESH AIR

Dilution of Virus by Dilution and/or Ventilation – More Fresh Air!

- Ventilation – Commercial and Industrial – Increase fresh air – set fresh air dampers to maximum openings on HVAC systems to maximize fresh air intake – over-ride energy controls – will increase energy costs.



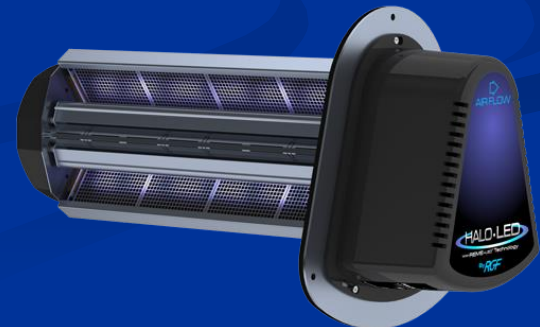
EXPOSURE CONTROL – DESTRUCTION

➤ Needle Point Ionization Technology (e.g., Nu-Calgon I-Wave & REM HALO-LED™ Whole Home In-Duct Air Purifier)

Burkett - ASHRAE J., 9/2021

- Unit magnetized and sticks to indoor unit fan.
- Nu-Calgon will treat up to 6-RT area or ~6,000 ft².
- Efficiency reported to 64.3%, 89.1%, and 96.4% for times of 15, 30, and 45 minutes respectively.
- Nu-Calgon Cost: ~\$400 plus installation (\$800; HALO: ~\$1,180 installed. – Tube replacement at ~4.5 yrs.

Bipolar ionization has received a lot of attention since the start of the current pandemic. Ionization is typically classified as either needlepoint ionizers or corona discharge ionizers (dielectric barrier). Ionizers produce positively charged ions, negatively charged ions, or both. A study by Hyun, et al., looked at the effect of corona discharge-generated air ions on aerosolized bacteriophage MS2.¹³ The test separated the antiviral efficiency of the ozone produced in the ion creation process (30 ppb at 4.52%). The results showed that the antiviral efficiency for bipolar ions was greater than either positive or negative ions individually, and the antiviral efficiency of the bipolar air ions at 10^7 ions/cm³ concentration was 64.3%, 89.1% and 96.4% with exposure times of 15, 30 and 45 minutes.¹³



EXPOSURE CONTROL – DESTRUCTION

➤ ***Ionized Hydrogen Peroxide Systems*** (e.g., RGF's Reme Halo in-duct air purifier - <https://www.rgf.com/products/air/remehalo/#undefined>).

- **REME® Cell technology with UV-C light to create low level, airborne hydrogen peroxide throughout the air-conditioned space reducing airborne and surface bacteria, viruses, odors, and mold.**
- **Cost: \$450 to \$650 for residential unit; \$780 installed. Cell replacement ~ every 2 years**
- **Must control H₂O₂ concentration.**
- **Reduces virus concentrations on surfaces by 4-log or a factor of 10,000.**

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Chemical disinfectants like hypochlorite, peroxy-monosulfate, alcohols, quaternary ammonium compounds and hydrogen peroxide are typical for surface disinfection of viruses.³¹ Vaporized hydrogen peroxide (VHP) has also been used in engineered disinfection systems for control of viruses.³¹ A study by Goyal, et al., has showed a 4-log reduction or greater for viruses dried on surfaces.³² VHP requires spaces to be sealed to prevent the vapor from escaping. Also, the space must be unoccupied since high concentrations of VHP can be hazardous.¹



Other products being considered are hypochlorite, peroxy-monosulfate, alcohols and quaternary ammonium compounds

EXPOSURE CONTROL – DESTRUCTION

➤ Novaerus Air Purifier Technology

- 3 sizes; treat 120 ft², 900 ft² and 3,000 ft².
- “NanoStrike patented technology destroys viruses, microorganisms, and bacteria at the DNA level:
 - Plasma coils create energy field that kills ALL germs and pathogens in sub-second time.
 - 99.9+% effective at eliminating Influenza pathogens, SARS-Cov-2 (Covid-19), and MRSA
 - Kills ALL airborne microorganisms at the DNA level as small as 1 nanometer!”

Hays Consolidated Independent School District in Texas considering spending ~\$4 million on technology

(<https://bellmedical.com/novaerus-portable-air-purifier>).



Monthly Filter Replacement

EXPOSURE CONTROL – DESTRUCTION

➤ Ultraviolet-C (UVC):

- 1.2 mJ/cm² to 2 mJ/cm² inactivated 95% to 99.9% of virus.
- At reg. limit of 23 mJ/cm² 90%, 95% and 99% of virus destroyed in 8, 11 and 25 minutes respectively.
- Danger to eyes.
- Maint. - must ensure bulbs not burned out.



Burkett - ASHRAE J., 9/2021

Far-UV-C refers to devices that operate in the 207 nm to 222 nm wavelength range.²⁴ UV-C light in this range is strongly absorbed by biological materials and doesn't penetrate through the outer dead-cell layers (stratum corneum) on the surface of human skin or the outer tear layer of the eye.²⁴ Since far-UV-C can only penetrate a few micrometers, it cannot reach living human cells in the skin or eyes.²⁵ However, this light can still inactivate bacteria and viruses with efficiencies comparable to UV-C in the 254 nm wavelength due to the virus's smaller cell size.²⁴ Buonanno, et al., found that low doses (1.2 mJ/cm² to 1.7 mJ/cm²) of 222 nm light inactivated 99.9% of the airborne human coronavirus tested.²⁵ Welch, et al., also found that 2 mJ/cm² of 222 nm light could inactivate 95% or more of aerosolized H1N1 influenza virus.²⁴ The threshold limit value (TLV) for 222 nm light to which the public can be exposed is 23 mJ/cm² per eight-hour exposure.²⁵ Based on far-UV-C exposure set at the regulatory limit, continuous exposure could result in 90% viral inactivation of airborne viruses in about eight minutes, 95% in 11 minutes, 99% in 16 minutes and 99.9% in 25 minutes.²⁵

EXPOSURE CONTROL – REMOVAL

Destruction or Removal:

- **Very High Efficiency Filters (at least MERV-13 to 17 filters depending on particle size)**

(<https://www.ashrae.org/file%20library/technical%20resources/covid-19/guidance-for-the-re-opening-of-schools.pdf>).



Burkett - ASHRAE J., 9/2021

TABLE 3 Minimum efficiency reporting value (MERV) performance.²⁰

MERV	COMPOSITE AVERAGE PARTICLE SIZE EFFICIENCY, % IN SIZE RANGE		
	Range 1 (0.3 µm to 1.0 µm)	Range 2 (1.0 µm to 3.0 µm)	Range 3 (3.0 µm to 10.0 µm)
8	N/A	20 ≤ E ₂	70 ≤ E ₃
9	N/A	35 ≤ E ₂	75 ≤ E ₃
10	N/A	50 ≤ E ₂	80 ≤ E ₃
11	20 ≤ E ₁	65 ≤ E ₂	85 ≤ E ₃
12	35 ≤ E ₁	80 ≤ E ₂	90 ≤ E ₃
13	50 ≤ E ₁	85 ≤ E ₂	90 ≤ E ₃
14	75 ≤ E ₁	90 ≤ E ₂	95 ≤ E ₃
15	85 ≤ E ₁	90 ≤ E ₂	95 ≤ E ₃
16	95 ≤ E ₁	95 ≤ E ₂	95 ≤ E ₃

Note: Data taken from ASHRAE Standard 52.2-2017 Table 12-1.

MERV (Minimum Efficiency Reporting Value)

Filter MERV of 16+ for 0.1 µm particles

EXPOSURE CONTROL – OZONE - NO

Ozone (O₃) Generators Alone:

- Health Effects on Respiratory Tract.
- Control of Levels in Space
Difficult – produce fixed amount of ozone over time & spaces will have different volumes and ventilation rates – Will not know concentration.

Burkett - ASHRAE J., 9/2021

Ozone, even at low levels, can produce respiratory issues in humans and actually cause other health risks through the formation of formaldehydes and aldehydes.²⁰ ASHRAE states that based on current science there is “no consensus on the safe level of ozone.”²⁰

ASHRAE Standard 62.1-2019, Table D-1²⁰ lists the eight-hour limit at 0.07 ppm, and the EPA and other agencies suggest avoiding the use of air cleaners that use ozone.^{20,40}



EXPOSURE CONTROL – DESTRUCTION

➤ Photocatalytic Oxidation (PCO)

- Used UV light to activate a catalyst such as TiO_2 .
- 90% to 99.8% of virus inactivated after 30 minutes. ~80% reduction from PCO alone and essentially all eliminated accounting for the UV.
- Potential to create formaldehyde.
- Catalyst performance drops with time.
- Developing technology.

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Photocatalytic oxidation (PCO) uses a UV light to enable chemical change (oxidation or reduction) by photon activated catalysis.¹⁹ The most common catalyst is titanium dioxide (TiO_2), but others are also used.²⁰ A study by Guillard, et al., showed that photocatalysis provided an 80% reduction in the avian influenza virus (A/H5N2), not counting the UV light.²¹ When the UV light was added, the virus was completely eliminated in a single pass.²¹

Studies have shown inactivation of viruses by photocatalysis is initiated by their adsorption onto the catalyst's nanoparticles followed by an attack on the protein capsid.²² Other studies suggest the inactivation is due to free hydroxyl radicals.²² Another study by Kozlova, et al., found that the vaccinia virus and influenza A virus (H3N2) were inactivated 90% to 99.8% after 30 minutes of exposure.²³ However, despite the promising results, PCO has the potential for production of by-products like formaldehyde due to incomplete oxidization.^{19,20} Also, there is a potential reduction in catalyst efficiency over time.^{19,20} These limitations should be evaluated when implementing this technology.

EXPOSURE CONTROL – DESTRUCTION

➤ Silver Nano Particles:

- Small silver particles, and silver in general, is a biocide.
- Use of 1 to 10 ppm concentrations were found to inhibit COVID-19; degree unknown.
- NIOSH REL for metal dust is 10 $\mu\text{g}/\text{m}^3$; regs. under development.
- Developing technology.

Burkett - ASHRAE J., 9/2021

Silver nanoparticles (AgNP) have been used in commercial virus sprays for surface disinfection of viruses. Silver has broad spectrum antimicrobial action against various bacteria, fungi and viruses.³³ Studies have shown that AgNP concentrations between 10 ppm and 100 ppm have antiviral effect.³³ Jeremiah, et al., found that concentrations between 1 ppm and 10 ppm were able to inhibit SARS-CoV-2.³³ Regulations for AgNP are still in development with the current NIOSH recommended exposure limit for silver metal dust and soluble compounds at 10 $\mu\text{g}/\text{m}^3$ as an eight-hour time-weighted average airborne concentration.^{34,35} This limit was developed to protect against argyria and argyrosis.³⁴

EXPOSURE CONTROL – EMERGING

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Other Emerging Technologies:

- Vacuum UV (VUV) - Reported to remove 90% of viruses in 90 seconds.
- Enzyme Filters.
- Desiccant Dehumidifiers.
- Essential Oils – Reported to removed 99% of virus in 60 minutes.

All need further research.

Additional Methods

In addition to the methods listed above, several other methods have been proposed that still need to be vetted for applicability and performance. A few are below.

Vacuum UV (VUV) has been proposed as a method to inactivate airborne viruses. A study by Kim, et al., showed a 90% inactivation efficiency for MS2 viruses under a VUV irradiation time of 0.009 seconds using a photocatalysis process.³⁶ It should be noted that VUV produces ozone that would have to be mediated.

Enzyme filters can eradicate microbes by attacking the microbial cell membrane if they come into close contact with the microbes. However, the adhesion of particles over time on the filter surface can prevent the close contact between the enzymes and microbes on the filter and reduce its performance.³⁷ Preliminary studies have shown little difference in performance between filters with and without enzymes.³⁷

Desiccant rotors have been adapted for indoor air cleaning. Silica gel rotors were shown in testing to provide high air cleaning efficiency (94% or higher for VOCs), which could be applied to virus mitigation as well.³⁷

Research on essential oils and their effect on microbes has been a topic of study for many years. However, ambiguity in the research makes the reproducibility of many of these tests difficult.³⁸ Brochot, et al., found that an essential oil blend produced a 99% reduction in H1N1 and HSV-1 with a 60-minute contact time.³⁹ Since some of these essential oils may also be toxic to human cells or cause hypersensitivity reactions in some occupants, further research needs to be done.³⁷

FOUR THINGS TO REMEMBER!

1. **Personal Protective Equipment (PPE) is the least desirable way to protect people.**
2. **Masks are not PPE.**
3. **Scientific evidence suggests COVID-19 particles are mostly small aerosols not droplets, which means respirators, not masks, needed to protect the lungs and would make the 6' rule effectively meaningless.**
4. **Smaller particles are likely a greater cause of disease since they get past PPE and can reach deep into the lungs.**

Use Engineering Controls of **Dilution and **Destruction**.**

THANK YOU

Questions Please

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